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ANALYSIS OF THE
ASBESTOS PERMISSIBLE EXPOSURE LEVEL THRESHOLD STANDARD

by

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ABSTRACT

This thesis examines the reasoning of the Occupational Safety and Health Administration's (OSHA) decision to set stringent exposure levels for airborne asbestos in the work place. Technical recommendations from the National Institute for Occupational Safety and Health (NIOSH), the Bureau of Mines, and the American Conference of Governmental Industrial Hygienists were presented to OSHA for consideration. OSHA and the Environmental Protection Agency (EPA) set industry standards for permissible exposure levels (PEL) of airborne asbestos. Exposure to asbestos poses a health hazard to workers, their families, and consumers of asbestos products. Because it poses an unreasonable risk to human life, OSHA has repeatedly lowered the Permissible Exposure Levels and the EPA will ban the manufacture, importation, processing and commercial distribution of asbestos containing products from the United States in phases by 1997. These decisions may have been made too hastily because of the long latency (15-40 years) period before cancer develops, and the added risks that smoking imposes.

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I. INTRODUCTION

A. General

Asbestos is a very versatile material that is resistant to both heat and acids. Because of its versatility and past appeal, there is a good chance you have been exposed to it in some form during your life. Common uses include asbestos cement sheeting, house shingles, sprayed on asbestos insulation, paint additives to produce varying textures, floor tile, heat shielding around fireplaces and stoves, beer and fruit juice filtration systems, brake pads, clutches, railway friction materials, fire curtains in theaters, wrapping around welding rods to slow the burn of the rods, talcum for condoms and many others. When asbestos is encapsulated or sealed from the environment, it poses no threat. If the exterior seal containing the asbestos fiber breaks, it is considered friable. In this state, it can release small fibers that are dangerous to humans.

The National Institute for Occupational Safety and Health (NIOSH), working for the U.S. Department of Health and Human Services' Center for Disease Control, has made many recommendations to the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) on suggested permissive exposure levels (PEL's) of airborne asbestos in the work place. This intervention by the government, attempts to provide a safe working environment for all employees.

Since 1971, the permissible exposure level has dropped from 12 fibers per cubic centimeter (f/cc) to its present level of 0.2 f/cc. Asbestos manufacturers are repeatedly sued for failure to inform their employees about the dangers associated with breathing and ingesting asbestos. Johns-Manville Corporation was forced to file for bankruptcy because liabilities from litigation were so great. Johns-Manville then set up two separate trust funds, and an injunction to prevent the public from suing them. Once completed, they reorganized and changed their name to the Manville Corporation.

Fibers enter the body by breathing or ingesting them. There are no immediately apparent symptoms to workers because of long latency period (15-40 years). Asbestos fibers breathed become trapped in the lungs. If swallowed, fibers enter the gastrointestinal track and are transported to other internal organs like the brain, pancreas, liver, kidneys, spleen or thyroid glands, as detected in autopsies. Urine samples of both miners and their families have shown fibers also can pass through the body.

Jock McCulloch has explained in simple English what happens to the lungs after breathing asbestos.

> "Once the foreign material enters the body, defensive cells gather to the site thereby setting up an inflammation. If the irritation is prolonged by a fibrosis, scar tissue may form. Such tissue is inelastic and over time will tend to shrink. In the lungs this type

of damage leads to reduced function that remains unnoticed for years because of that organ's excess capacity. If exposure continues and scar tissue widens, the person will gradually become aware of breathlessness, and exhaustion will occur even after the most casual exercise. As the disease progresses the individual becomes prone to other infections and diseases, such as bronchitis and pneumonia." [Ref 1: pp. 42-43]

Within the next decade, many workers exposed to asbestos during World War II will enter the latency period and begin to exhibit effects from past exposure. Since most workers from that era are near retirement age, the burden of care shifts from the employer to the U.S. Government as they begin to draw medicare benefits.

B. Background

The American Society for Testing and Materials (ASTM) defines asbestos to be a term applied to six naturally occurring minerals exploited for their desirable physical properties. They are classified as either the serpentine or amphibole mineral group and are only to be considered asbestos if their length-to-width ratio is less than 20:1.

[Ref 2: p. 3]

Asbestos fiber release can occur at many times during a products' life. Fibers released into the atmosphere are invisible, odorless, can travel extended distances and remain airborne for long periods of time. Even if the fibers settle, air movement may send them airborne again. The public may be exposed unknowingly and may not know how to protect themselves. The Occupational Safety and Health Administration has set standards for the work environment and the Environmental Protection Agency (EPA) sets standards for non-work environments.

The ideal chemical composition of the commercial asbestos mineral families are:

a. Serpentine Group

1. Chrysotile { $Mg_3Si_2O_5(OH)_4$ }

- Sometimes called "white asbestos." May be very long and pliable.

b. Amphibole Mineral Group

1. Gunnerite asbestos { $Fe_7Si_8O_{22}(OH)_2$ }

- Normally, but improperly, called amosite.

2. Riebeckite asbestos { $Na_2Fe_3^{2+}Fe_2^{3+}Si_8(OH)_{22}$ }

- Usually called crocidolite or "blue asbestos."

- Straighter and more rigid - can be drawn deeper into the lungs.

3. Anthophyllite asbestos { $Mg_7Si_8O_{22}(OH)_2$ }

4. Tremolite asbestos { $Ca_2Mg_5Si_8O_{22}(OH)_2$ }

5. Actinolite asbestos { $Ca_2(Mg,Fe^{2+})_5Si_8O_{22}(OH)_2$ }

The value of an asbestos fiber lies in its length. They are graded and priced according to size and their ability to be spun.

No. 1 Crude: Greater than 19 mm (3/4").
No. 2 Crude: 9 - 19 mm (3/8 - 3/4").
No. 6 Crude: Less than 3 mm
No. 7 Crude: Less than 3 mm [Ref 2: pp. 3-12]

Most chrysotile asbestos fibers are flexible enough to be spun into thread or yarn, which can then be woven into cloth. The most useful and valuable products are the thread and cloth. Asbestos cloth and rope have been used in making fire-rated theater curtains, fireman's gloves, blankets and bags, fire mats, gaskets, acid resistant and electrical parts, wicks, heat insulators, brakes, clutch linings, friction materials, and pipe and joint packing. Non-spinning fibers are used for applications such as furnace insulation, flooring, roofing papers, pipe covers and insulation, strengthening compounds for cement, roof and house shingles, and many other heat insulating products.

C. Methodology

Research of the recommendations made by the National Institute for Occupational Safety and Health should identify the reasoning behind the stringent standards. By examining the value of a life, the government policy will be reviewed to assess if we are efficiently allocating resources.

Primary research questions are "What were the determining factors in setting the standards at their present levels? What have they accomplished?" Secondary questions asked are "As a result of the more stringent standards, what are the resultant costs to society, firms, and consumers? Are we able to determine if this is a potential Pareto Improvement? i. e. the benefits exceed the costs incurred."

D. **Scope and Limitations**

This research focuses on reasons the standards were lowered, what evidence was presented to justify lowering them and what effect the reduced standards have had on society. The study will attempt to place a value on the number of lives saved and the externalities imposed by these standards.

Research into the effects of asbestos is continuously being conducted. Interviews with testing laboratories, state and governmental officials were taken from a limited sample. Recommendations and conclusions based on this sample are the sole opinion of the author.

II. HOW ASBESTOS IS MEASURED

A. Background

Near the turn of the century, the asbestos market developed and flourished. Major deposits in Canada, Australia, South Africa, Italy and the U.S.S.R. were located and mining commenced. As the production of asbestos increased, the medical community noted increases in respiratory diseases among workers. Studies found a correlation between the effects caused by inhalation of coal dust, and airborne asbestos. Industrial Hygienists and the medical profession began studying effects of breathing and ingesting airborne asbestos fibers.

Testing over the years has improved significantly. The costs of testing still play a key role in the measurement of representative airborne asbestos samples. From 1940 through the late sixties, asbestos particles were measured mainly by sight. Dust clouds from asbestos mines could be seen for miles, suggesting very high particulate concentrations. A thick cloud of dust meant workers would be breathing more particles. Photographs taken in some of the mines could not be developed because the "snow" in the foreground caused by airborne particles obliterated the picture. During inspections, mining companies wanted to project the best image

and show good working conditions to the inspector. Dust control in the early testing days meant slowing the production line and wetting everything before an inspection.
[Ref 1: p. 155]

B. Standards Set

Before 1970, very little data about dust concentration or fiber levels were collected. In 1964, Australian mines set a voluntary limit of 5,000,000 particles per cubic foot (5 mp/cf or 177 particles per cubic centimeter (p/cc)). On January 23, 1973, the standard changed from particles of dust to number of fibers. It also became much more stringent - 4 f/cc using the membrane filter method. [Ref 1: p. 147] Since workers move about the plant or mine often, they are exposed to different operations and differing exposure levels. To get a representative sample of air that workers are breathing, they now carry sampling pumps on their bodies with an air intake tube placed near their collar.

Humans inhale approximately 10 cubic meters (10,000,000 cc) of air per day. [Ref 3: p. 108] The average worker inhales between 2,500,000 - 4,166,667 cubic centimeters of air per working shift. OSHA's current allowable time weighted -erage (TWA) permissible exposure level is 0.2 f/cc for an eight hour work day. If we assume the plant meets the airborne asbestos standard of 0.2 f/cc, the average worker could be inhaling between 500,000 (0.2 f/cc * 2,500,000 cc of air) and

833,333 "permissible fibers." The standard of 0.2 f/cc only includes asbestos fibers that exceed 5 microns in length. Therefore, the worker could be breathing many more than 833,333 fibers per day. The risks caused by fibers smaller than 5 microns are not yet known but could pose a risk to us.

C. **Sampling**

In the late sixties, a sampling of airborne asbestos in a plant was taken using the Midget Impinger. This was a static sampler that could be moved to various locations in the plant. Because of the magnification required, only a fraction of the sample could be reviewed at a time. Because of the aerodynamics of asbestos fibers, they are rarely evenly distributed and the location of the sample affects the readings.

Later methods of sampling included the Membrane Filter Method, Light Microscopy, which failed to measure the smallest fibers, and Electron Microscopy, which took several hours to process and was very expensive. The current standard is the Phase Contrast Optical Microscopy or OSHA Reference Method (ORM). [Ref 4: p. 38] All the above methods have one thing in common, fibers shorter than five microns are difficult to detect using current technology and economically accepted methods of analysis.

According to OSHA

> "The permissible exposure levels were chosen on the technological limitations of engineering and work practice controls, and the limitations of the available monitoring technology." [Ref 5: p. 3727]

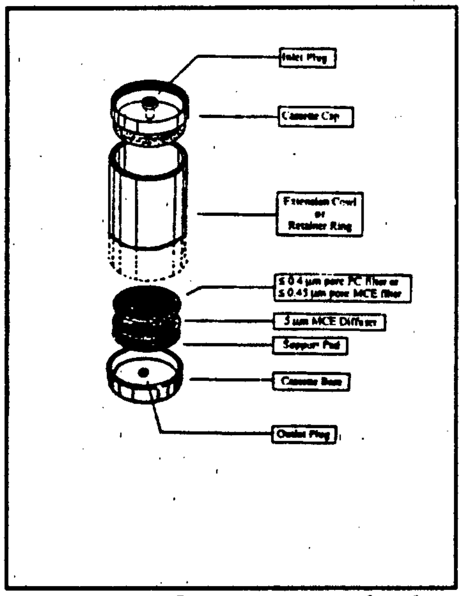
Technicians at testing labs confirmed OSHA's statement. Using the mandatory ORM, they could not distinguish asbestos from fiberglass or other airborne fibers. Using Transmission Electron Microscopy (TEM), asbestos fibers can be identified. In the TEM process, an electron beam passes through the sample and reflects the fibers onto a phosphorous screen. Fibers with a length-to-width ratio (aspect ratio) of 3:1 or more are counted. [Ref 4: p. 39] The approximate costs for various testing methods in the Monterey, California area are:

a. $20.00 Bulk Samples
b. $18.00 ORM
c. $275.00 TEM

In the OSHA Reference Method, the filter is cut into samples. The samples are placed in acetone, which dissolves the filter. As a result, the fibers become suspended in a carbon medium where they can be counted. At least 10% of the sample set (or a minimum of two samples) must be taken from blank filters. [Ref 4: p. 39] Blanks may be taken from an unopened filter or a filter exposed to the testing environment for about 30 seconds. Sampled blanks showing greater than 7 fibers per 100 fields must be rejected because of possible contamination. The averaged readings of the blanks are subtracted from the final sample results. There are a few observations about the OSHA Reference Method worth mentioning.

a. The suggested filter has a 25 mm diameter with a total area of 491 mm^2. The stated effective collection area of the filter is 385 mm^2 suggests the cowl used in testing covers 105.9 mm^2 (21%) of the filter when secured in place (see Figure 1). [Ref 6: p. 382]

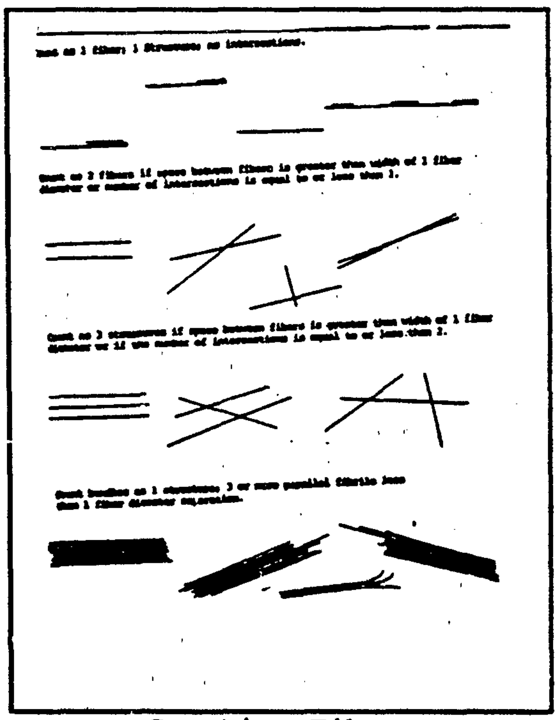
b. The microscope measures a field diameter of 100 (+/-) 2 micrometers for a total area of 0.00785 mm^2 (0.00204% of the effective filter area). Enough fields must be counted to yield 100 fibers. At least 20 fields but no more than 100 fields (0.0041 - 0.204% of effective area) must be counted. Less than one percent of the sample is used as a representation of the entire population. Figures 2 and 3 show how fibers are counted. [Ref 6: pp. 389-390]



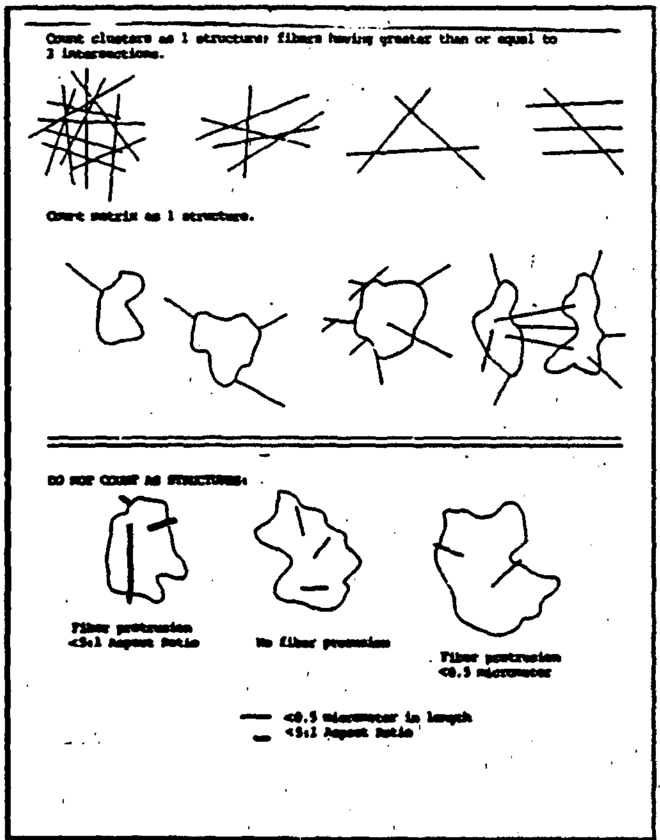
OSHA Reference Method Filter
Figure 1

c. With a circular filter, the velocity profile for laminar flow would tend to cause a higher concentration near the center of the filter. Since the air velocity is greatest near the center of the filter along with the volume of air passing through it, more fibers should be trapped in this area. If all graticule fields are taken from the center of the filter, the sample may be biased higher than actual work space conditions. Conversely, if all samples are taken near the outer edge, a false conclusion that the air concentration is within limits might be reached. At the extreme, samples taken from the area shielded by the cowl would give erroneous data.

As OSHA and lab technicians stated, sampling and testing technology is the limiting aspect in determining how stringent the standards are set. Using the mandatory OSHA Reference Method, reasonable sample costs are charged and the labs can count fibers collected. The problem is that labs are unable to identify the type of particles they have measured and may be causing undue alarm.



Counting Fibers
Figure 2



Counting Clusters
Figure 3

III. HISTORY

Asbestos has had a very checkered past. Throughout history it has been known in different periods as a miracle mineral and most recently as a toxic carcinogen. It is unique because it's mineral properties allow it to resist damage from both extreme heat and acids.

Research over the past few decades has shown a positive correlation between its' use and disease. Because of it's appeal, asbestos has been used in thousands of applications. With advances in modern medical technology, the average life span has lengthened. Since the latency period for asbestos varies between 15 and 40 years, we are only just recently realizing it's effects on human health.

A chronology of the history of asbestos is listed below. Worldwide production figures (1 short ton = 2000 pounds) and U.S. consumption suggests an early trend of growing popularity followed by declining production as medical effects and governmental regulations were enacted.

YEAR	Worldwide Production	U.S. Consumption
	(short tons)	
	[Ref 2: pp. 1-12]	[Ref 7]
1879	300	49
1910		56,904
1931	500,000	137,875
1938		187,150
1959	750,000	754,045
1968	4,000,000	816,812
1972	4,614,270	809,096
1973	4,614,270	876,336
1981	4,780,718	384,706
1983	4,582,303	239,201
1985	4,248,988	178,574
1987	4,227,662	92,902
1988	4,322,805	78,654
1989	4,325,487	60,964

- **2500 B.C.**
  Pottery in Finland showed traces of asbestos.

- **456 B.C.**
  Roman Heroditus referred to asbestos as a cloth for retaining ashes of the dead after cremation. [Ref 1: p. 8]

- **1 A.D.**
  "Sickness of the lungs" in slaves who weaved asbestos cloth was noted by the Greek geographer Strabo and Roman naturalist Pliny the Elder [Ref 8: p. 57].

- **1698**
  Many finds of asbestos-containing products were discovered

along Brandywine Creek in Pennsylvania. [Ref 3: p. 44]

- 1818
  Asbestos was discovered on Staten Island and mining started soon afterward. [Ref 3: p. 44]

- 1866
  Asbestos was first used as an insulating material when mixed with sodium silicate. [Ref 9: p. 91]

- 1870
  Asbestos was first used in asbestos cement. [Ref 9: p. 91]

- 1878
  Large asbestos deposits were discovered in Quebec.

- 1879
  World's first commercial asbestos mine opened at Thetford in Quebec, Canada - 300 tons of asbestos were produced [Ref 8: p. 57].

- 1901
  Johns-Manville Corporation was formed.

- 1906
  Dr. Montague Murray documented the first case of death resulting specifically from asbestosis (pulmonary fibrosis) in 1899. He studied, and then autopsied the last survivor in a group of 10 workers employed in a carding room. He reported his evidence in 1906 before the British Departmental Commission on Industrial Disease. [Ref 1: p. 37]

- 1916
  British Turner Brothers, the British equivalent of Johns-Manville Corporation, was established.

- 1924 July
  Dr. William E. Cooke published "Fibrosis of the Lungs due to the Inhalation of Asbestos Dust" in the British Medical Journal documenting death caused by asbestos. He is also credited with naming the disease asbestosis.

• 1931
The British Parliament made asbestosis a compensable disease for those who worked with it. Improved methods of dust suppression and exhaust ventilation were required in textile factories along with periodic examinations of asbestos textile workers [Ref 8: p. 59].

• 1936
Johns-Manville Corporation published the magazine "Asbestos" to propagate the utility of asbestos products without warning the public of its known fatal properties [Ref 8: p. 60].

• 1938
The American Conference of Governmental Industrial Hygienists (ACGIH) set airborne asbestos standards at 177 particles per cubic centimeter (p/cc). This became the unofficial standard. [Ref 1: p. 65]

• 1940
Asbestos was sprayed on building components for fire proofing, sound attenuation and decoration. It was used in schools and in the production of gas masks during the war.

• 1943
The Navy Department and United Stated Maritime Commission published the booklet <u>Minimum Requirements for Safety and Industrial Health in Contract Shipyards</u>. It warned workers that asbestosis could be contracted from any "job in which asbestos is breathed." [Ref 8: p. 60]

• 1949
Johns-Manville Corporation employed a private physician to survey the workers of their Canadian Asbestos mines. Reported results of a significant number of lung mutations were kept confidential and remained unpublished [Ref 8: p. 61].

• 1955
Dr. Richard Doll, Director of the Statistical Research Unit of the British Medical Research Council, studied over 113 autopsies of asbestos workers and drew a definite link between asbestos exposure and lung cancer. While the medical profession recognized a causal relationship from that point on, industry was not convinced [Ref 8: p. 61].

- 1962

  Dr. Irving J. Selikoff, Head of Environmental Medicine at the Mount Sinai School of Medicine, opened informal clinics in union halls around New York City and tested the workers of two local asbestos unions [Ref 8: pp. 60-61].

- 1964

  Australian mines adopted the voluntary dust particle standard of 177 p/cc. [Ref 1: p. 147]

  Dr. Irving J. Selikoff published his study in the Journal of American Medical Association and furnished the first incontrovertible evidence that industrial exposure to asbestos was potentially fatal. He established a sound procedure for future studies in this area. He also linked the effects of cigarette smoking and asbestos as a catalyst to an increased risk of developing cancer [Ref 8: p. 62].

  Johns-Manville Corporation began putting cautionary labels on its products [Ref 8: p. 62].

- 1968

  British Occupational Hygiene Society recommended a standard of 2 fibers per cubic centimeter (f/cc) based on a single piece of research by Turner Brothers. The paper estimated the risk at 1% for a man working in the industry for a 50 year period. The study failed to account for dangers already known, such as mesothelioma and bronchiogenic carcinoma [Ref 1: pp. 66-67].

  February
  South Africa set industrial dust level standards at 45 f/cc. [Ref 1: p. 55]

- 1970

  The National Environmental Policy Act of 1969 was signed into law (91-190) establishing the Environmental Protection Agency (EPA).

  The Occupational Safety and Health Act was signed into law establishing the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH).

- 1971
  May
  OSHA set the first work place standard limiting worker exposure to airborne asbestos. The standard was based on a time weighted average (TWA) of an eight hour work day, and allowed a permissible exposure level (PEL) of 12 f/cc.

  December
  The EPA issued standards for asbestos emissions. AFL-CIO lobbied OSHA to place stringent standards limiting workers exposure to asbestos. An emergency time weighted average permissible exposure level standard of 5 f/cc was set by OSHA.

- 1972
  June
  OSHA reduced the "permanent standard" for occupational exposure to asbestos from 5 f/cc to 2 f/cc, to be accomplished by July, 1976 in all occupational areas.

- 1973
  January
  Borel Lawsuit against 11 asbestos manufacturers became the first case to go to jury. The case was won by a widow whose husband died from a severe case of asbestosis and mesothelioma. He had worked in an asbestos factory for over 30 years and was never warned of the dangers of asbestos [Ref 8: p. 64].

  April
  EPA listed asbestos as a hazardous air pollutant, established a "No Visible Emission" standard for manufacturers, and banned the use of spray applied asbestos-containing materials.

  October
  OSHA recommended lowering the "permanent" time weighted average permissible exposure level standard from 2 f/cc to 0.5 f/cc.

- 1975
  The EPA banned the use of asbestos-containing pipe wrap.

- 1976
  March
  The Mine Safety and Health Administration (MSHA) set

standards at 2 f/cc for pit and underground mining and milling.

July
OSHA's reduced work place standard of 2 f/cc took effect.

December
NIOSH recommended to OSHA that the permissible exposure level be lowered from 2 f/cc to 0.1 f/cc (the lowest level that available technology could detect).

- 1977
  Clean Air Act (CAA) Amendments of Bill HR 6161 set new air quality standards to be met by all U.S. cities by 1982. The Act was passed in an attempt to protect the public's health.

  December
  Consumer Product Safety Commission (CPSC) issued rules banning consumer patching compounds and artificial emberizing agents in an attempt to reduce household exposure to asbestos.

- 1978
  June
  EPA extended the ban to all uses of sprayed on asbestos.

  July
  An American Cancer Society study of 92 asbestos factory workers exposed to heavy doses of asbestos dust for one month showed a slight to doubling increase in asbestos related disease and lung cancer 5 - 35 years after exposure [Ref 8: p. 66].

  August
  13 million hand held hair dryers believed to be in use were publicized as containing asbestos linings. A television station tried to get interest from the CPSC. The CPSC determined that this was not serious threat, based on a $20,000 study by a management consultant firm. Without adequate factual evidence, the consultant reported asbestos is no longer used in the manufacture of hair dryers. [Ref 10]

- 1979
  March
  The television station conducted its own research on the use of asbestos in hair dryers and broadcast its results,

thereby alerting public of asbestos threat. [Ref 10]

Environmental Defense Fund (EDF), a Washington D.C. based group, backed by the National Education Association, the American Federation of Teachers, and the National Parents-Teachers Association (PTA) claimed millions of children were exposed to asbestos in their schools. They petitioned the EPA to inspect 87,000 schools across the nation for asbestos [Ref 8: p. 68].

April
EPA alerted state officials of the potential high levels of asbestos in schools and initiated a technical assistance program to help schools identify and control friable asbestos containing materials [Ref 8: p. 68].

May
The CPSC announced it would approve voluntary corrective actions of the 11 major manufacturers of hand held hair dryers. Most hair dryers were recalled [Ref 8: p. 68].

Representative Millicent Fenwick (R-NJ) introduced a bill to the House Subcommittee on Labor Standards that required the Federal government to reimburse product liability claims of any U.S. citizen before December 1980. Johns-Manville Corporation, whose largest plant was in New Jersey, gladly supported the bill. However, it was dropped [Ref 8: p. 69].

Bill HR 3282 was approved by the House Education and Labor Committee in H REPT 96-197. The bill called for a new $330 million program to help schools find and remove hazardous asbestos. The committee rejected a proposal to assess the asbestos industry up to $30 million as its share of problem, in an effort to get the billed passed. They considered the issue too controversial [Ref 8: p. 69].

August
The Department of Transportation announced a rule requiring controls during transportation of friable asbestos [Ref 8: p. 69].

October
EPA received petitions to ban asbestos in asbestos-cement pipe. The EPA and CPSC announced their intent to consider regulating commercial uses of asbestos.

- 1980
CPSC issued an order for information submission on all

consumer product asbestos-containing materials.

June
House and Senate bills H 3282 and S 1658 signed as Public Law 96-270 "Asbestos School Hazard Detection and Control Act of 1980." The law authorized $22.5 million in fiscal years 1981 and 1982 for grants to states and local education agencies to find asbestos in school buildings. In fiscal years 1981 and 1982, it also authorized $75 million for interest free loans to local education agencies for containment or removal of the asbestos fibers [Ref 8: p. 70].

September
EPA proposed a rule to require reporting of production and exposure data on asbestos. They also proposed a rule requiring all private and public elementary and secondary schools to identify friable asbestos in their building by June 1983 [Ref 8: p. 71].

- 1981

September
The U.S. Department of Justice published the Attorney General's Asbestos Liability Report to Congress, advising the public of its right to sue asbestos manufacturers, distributors, architects, and contractors to recover costs of asbestos removal from buildings [Ref 8: p. 71].

December
EPA received a petition to ban asbestos in motor vehicle brake parts.

- 1982

March
HR 5735, introduced by Congressman George Miller (CA), et al., provided for the compensation of people who were disabled as a result of occupational exposure to asbestos or uranium ore, and to regulate the fair, adequate and equitable compensation of certain occupational disease victims. The bill received a hearing in the House and then was dropped [Ref 8: p. 72].

August
Johns-Manville Corporation filed for bankruptcy under Chapter 11 of the Federal Bankruptcy Code. The suspected cause was 16,500 lawsuits against it for asbestos related diseases. [Ref 2: p. 10]

- 1983

March
The EPA issued an urgent warning to the public and published Guidance for Controlling Friable Asbestos-Containing Materials in Buildings [Ref 8: p. 73].

July
EPA required schools to inspect for asbestos and report findings of asbestos to Parent Teacher Associations. School employees were to be notified of the asbestos locations and receive instructions for exposure reductions under the Toxic Substances Control Act (TSCA) of 1976.

November
OSHA issued an Emergency Temporary Standard (ETS) of 0.5 f/cc. The ETS was challenged by the asbestos industry and later revoked by the Federal Appeals Court.

- 1984

A wet process for milling operations was introduced.

March
The ETS was overturned in Federal District Court because the case presented by OSHA was not considered to be a "grave" risk.

April
OSHA proposed lowering the time weighted average permissible exposure level standard from 2 f/cc to 0.2 f/cc.

May
EPA sent a proposal to the Office of Management and Budget (OMB) to ban asbestos entirely and phase out its' use over the next ten years [Ref 8: p. 73].

July
HR 1310, the Math-Science Bill Amendment, passed by House and Senate, authorized transfer of the asbestos program from the Department of Education to the EPA, to aid in removing asbestos from school buildings. It authorized $50 million during fiscal years 1984 and 1985, and $100 million for each of the next five years. The funds provided 20-year interest free loans to be used exclusively for asbestos removal [Ref 8: p. 73].

August
HR 1310 was signed, becoming PL 98-377, and authorized the changes listed above.

April
The Congressional Investigating Committee found OMB guilty of stopping the EPA's May 1984 proposal to eliminate asbestos [Ref 8: p. 74].

- 1986
January
The EPA published the Asbestos Elimination Policy to ban certain asbestos products immediately, and phase out the remaining products over a ten year period.

June
OSHA published it's final ruling, reducing the permissible exposure level standard to 0.2 f/cc. It also suggested provisions for medical surveillance, record keeping, respirator use, and exposure monitoring. Labor unions thought OSHA didn't go far enough and felt the standard should have been set at 0.1 f/cc. On the other hand, the asbestos industry believed the standard was too stringent. As a result, both challenged the ruling.

September
CPSC required labeling of all household products that could release asbestos fibers.

October
The Asbestos Hazard Emergency Response Act of 1986, passed as Public Law 99-519, established regulations that required asbestos inspections of our nation's schools. It was to conduct a study of the health danger caused by asbestos in public buildings.

November
The Chief of Naval Operations issued the Asbestos Management Program to provide a safe and healthy work environment for all Navy employees.

- 1987
September
OSHA issued almost 1000 citations for failure to institute engineering controls and maintain exposure levels below the Time Weighted Average Permissible Exposure Limit of 0.2 f/cc.

- 1988
Manville Corporation filed for bankruptcy under Chapter 11 of the Federal Bankruptcy Code.

February
U.S. Court of Appeals for the District of Columbia Circuit upheld OSHA's finding of June 20, 1986. It found asbestos exposure poses a significant risk, but did not agree with OSHA's ban of sprayed on asbestos products and the short term exposure limit.

September
OSHA issued a short term excursion limit (EL) of 1 f/cc for a 30 minute sampling time as a result of the February 1988 ruling.

- 1989

July
EPA issued its final rule of the Toxic Substances Control Act. At staged intervals, it banned the manufacture, importation, processing and commercial distribution of asbestos. Asbestos will be phased out by 1997. They also issued the final ruling banning asbestos in automobile brakes and asbestos-cement pipe in a phased sequence.

December
OSHA removed it's ban on spraying asbestos-containing materials and changed the regulatory text on when construction employees must resume periodic medical monitoring.

- 1990

February
OSHA issued the final ruling on the Time Weighted Average Permissible Exposure Limit of 0.2 f/cc.

August
EPA's Stage 1 ban for manufacture, import, and processing of asbestos on flooring felt, roofing felt, pipeline wrap, asbestos/cement (A/C) flat sheet, A/C corrugated sheet, vinyl/asbestos floor tile, and asbestos clothing, took effect [Ref 11].

IV. ECONOMIC ANALYSIS OF MORE STRINGENT STANDARDS

A. BACKGROUND

Asbestos is an invisible, odorless carcinogen that the general public may not be aware they are breathing. People unknowingly exposed can't protect themselves. Fibers released into the atmosphere can travel extended distances and remain airborne for long periods of time. If the fibers settle out of the air, even the slightest movement could launch them airborne again. For these reasons, the government has set standards to protect people in the work place, through the Occupational Safety and Health Administration (OSHA). To protect the public and the environment, the Environmental Protection Agency (EPA) uses the power of the Clean Air Act to set Permissible Exposure Level standards.

The government has made significantly more stringent airborne asbestos standards on five different occasions.

- May 1971: The first numerical standard of 12 f/cc was enacted.
- December 1971: An emergency standard of 5 f/cc was set.
- June 1972: The standard was made even more stringent at 2 f/cc. Labor unions petitioned the government for more stringent standards. However, the Court of Appeals' decision in November, 1983 rescinded the Emergency Temporary Standard of 0.5 f/cc.

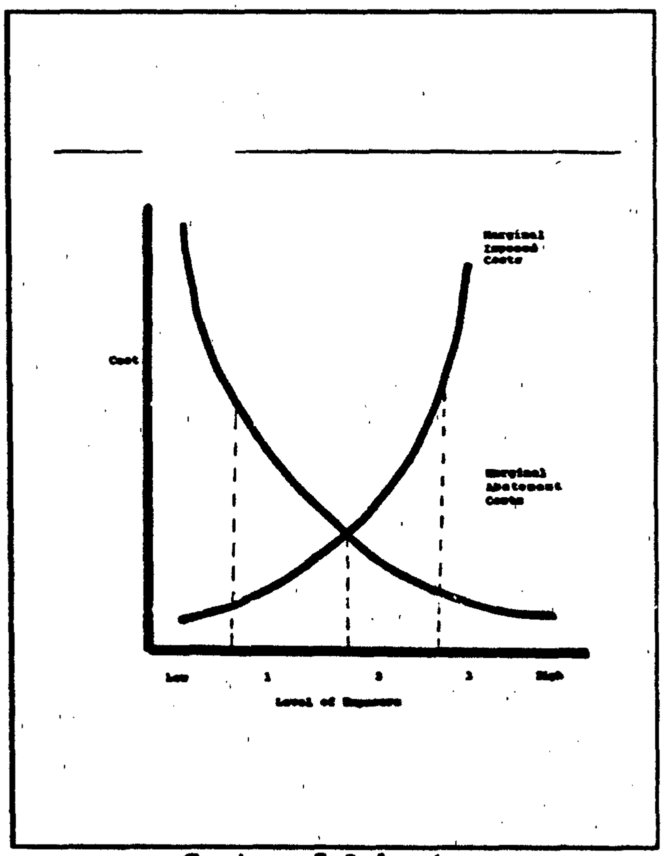
- August 1989: The EPA issued a final ruling to ban the manufacture, importation, processing and commercial distribution of any asbestos-related product. The ban is to be completed in phases ending in 1997.
- February 1990: OSHA made its final ruling lowering the standard to 0.2 f/cc.

Since change was not voluntary, there are imposed costs in setting more stringent standards. In chapter one, several questions were asked about why the standards were set, and if society has received greater benefits than the costs if they have incurred. "Government intervention in a Pareto Efficient economy arises from concern that the individual may not act in his own best interest." [Ref 12, p. 80] Stiglitz defines a Pareto Improvement as "changes that make some better off without making anyone worse off." [Ref 12: p. 93] This chapter attempts to evaluate if the governments' stricter standards are a potential Pareto Improvement. More stringent standards do not make asbestos firms better off because they strengthen the position of individuals suing them for damages. The attempt is to see if the winners won more than the losers have lost.

B. MODEL

A stricter standard makes the asbestos worker better off if it lowers the amount of fibers below a threshold that has a minimal risk of causing cancer. With new standards though, is the public worse off by paying more than it should for abatement? Recommendations by the National Institute of Occupational Safety and Health (NIOSH) to the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) should identify the reasoning for setting more stringent standards.

Figure 4 is a generic model of the costs imposed versus the level of exposure for a given set of regulations. In this model, costs imposed upon society include premature deaths of the work force and their families from breathing asbestos, suffering caused by painful breathing, and medical costs to care for the elderly and indigent because of inhalation of asbestos fibers. As the level of exposure increases, the risk of lung cancer, mesothelioma, and asbestosis also greatly increase and cause the curve to slope upward.



Costs of Asbestos
Figure 4

Abatement costs include protection of workers and inhabitants, and possibly the loss in welfare due to the substitution of inferior products for asbestos-containing products. To reduce the level of exposure requires some type of controls. The air must be filtered, the asbestos must be encapsulated or treated, or even be removed. Each increment that lowers exposure costs greater amounts of money. Therefore, the curve is downward sloping as the standards become more relaxed.

The area on the left of the graph (Point 1), suggests very high abatement costs but low imposed costs at a low level of exposure. On the far right (Point 3), a high exposure level shows high imposed costs because of excessively relaxed standards and low abatement costs. The lowest cost to society is the intersection of the two curves - where the marginal imposed costs just equal the marginal abatement costs.

The first step in using the model is attempting to identify where we lie on the graph. Ideally, if we locate our present position, intelligent policy decisions can be made to impose the least costs upon society. The government can enact policy decisions that move us toward the intersection of the two curves.

Because of the recently enacted very stringent standards, the asbestos-using industries have had to incur high abatement costs. Material costs include equipment such as High Efficiency Particulate Air (HEPA) vacuums, negatively pressurized plastic enclosure areas, portable exhaust ventilation systems, portable showers, wetting agents, and personal protective equipment such as "bunny suits" and respirators. Labor costs incurred include reduced productivity from extra precautions that must be taken, delays caused from identification and testing, and additional paperwork. Overhead is increased through higher liability insurance premiums and bonding rates. These costs, along with the costs of proper disposal, are passed on to the public through higher priced buildings, longer construction time frames and increased demolition and alteration costs.

C. Setting a Threshold

Dr. Irving J. Selikoff, Head of Environmental Medicine at the Mount Sinai School of Medicine is considered to be the premier researcher in industrial exposure to asbestos. He was the first to publish evidence that linked asbestos exposure to possible death in 1964. In 1979, Dr. Selikoff brought together an international panel of professionals that tried to determine "Based on Available Data, Can We Project an Acceptable Standard for Industrial use of Asbestos?" [Ref 13]

The panel included Dr. K. Robock, a physicist from Germany working for the Asbestos Institute for Occupational and Environmental Hygiene, Dr. Paul Kotin, a pathologist from Johns-Manville Health, Safety, and Environmental Department, Dr. Anders Englund, a clinician from Sweden working for the

Foundation for Industrial Safety and Health in the Construction Industry, and Mr. Sheldon Samuels of the Industrial Union Department of the AFL-CIO in Washington, DC. Responses from the panel as to whether we can project an acceptable standard on industrial use of asbestos included "Absolutely, Yes, Probably, and No" as explained below. [Ref 13]

Dr. Robock's response was "absolutely'. He believed that only excessive cancer risks were observed in groups of insulation workers who also smoked. He presented logarithmic tables showing the same group was the only one with a risk of mesothelioma. When animals were injected with asbestos fibers, the threshold for "tumor induction to occur" was about 100 million fibers per animal, suggesting a threshold exists. He concluded the threshold level in humans should be between 2 - 5 f/cc. [Ref 13: pp. 205-210]

Dr. Kotin's response was "yes". He also found it difficult to define what an acceptable standard might be. He thcught "acceptable" was highly personal, and said "what is an acceptable risk to Evil Knievel is not an acceptable risk to me." He went on to state

> "Rejection of threshold levels on the basis of models or projections by persons unaware or only partially aware of mechanisms of carcinogenesis represents an unwarranted conclusion in a highly complex area still debated by experts in the field."

He argued his point during hearings held by OSHA when they considered lowering the standards. [Ref 13: pp. 211-214]

Mr. Samuels responded with "Perhaps". He felt the standards are forcing the technology to come up with ways to reduce the thresholds to an acceptable level. The levels of the standards have been limited because of the technology currently available. [Ref 13: pp. 215-218]

The "No" response came from Dr. Englund who cited an International Agency for Research on Cancer monograph from 1977. The monograph concluded

> "it is not possible to assess whether there is a level of exposure in humans below which an increased risk of cancer would occur."

He went on to state that there are too many uncertainties involved to determine an acceptable threshold. [Ref 13: pp. 219-221] These uncertainties are one of the reasons four different answers were received from the four members of the panel. Since all studies recorded thus far have unknown or sketchy exposure concentration levels, the results of the more stringent standards may not be known for some time.

In 1976, NIOSH concluded that there is no "safe" level of exposure or threshold based on the studies available at the time (the first standard of 12 f/cc was made just five years earlier and with a 15-40 year latency period it is doubtful if any data existed!). They used the lack of evidence and felt the "standard should be set at the lowest level detectable by available analytical techniques." [Ref 14: p. 93]

In 1990, when OSHA made its final ruling on the 0.2 f/cc level, they stated

"The Permissible Exposure Levels were chosen based on the technological limitations of engineering and work practice controls, and the limitations of the available monitoring technology." [Ref 5: p. 3727]

According to the International Labor Organization, extensive information has been collected about miners in Quebec, asbestos cement workers in the Unitod States, and textile workers in the United Kingdom to determine hygiene standards.

" A cautious conclusion from the North American Studies is that at about 1.7 f/cc there might be a threshold or that the risk of developing asbestosis might be as low as 1%. In the textile plant in the United Kingdom, the conclusion was the concentration such that 'possible' asbestosis occurs in no more than 1% of men after 40 years' exposure could be as high as 1.1 f/cc or may have to be as low as 0.3 f/cc'." [Ref 15: p. 190]

Epidemiological studies, however, seem to support this threshold hypothesis [Ref 15: p. 192].

D. Differing Threshold Levels

There is a growing number of professionals who hold the general belief that a safe threshold exists below which asbestosis will not occur. Dr. Dewees is a professor of economics and law at the University of Toronto. In 1984, he worked as the Director of Research for the Ontario Royal Commission on Asbestos (RCA). The RCA studied the same abatement problems as the U.S. Environmental Protection Agency had in 1983, but concluded the risks from chrysotile are much lower than that from crocidolite and amosite.

Because of the long latency period, the number of life-years lost is smaller than that for industrial accidents. This causes much higher costs for disease prevention than for accident control. Realizing the controversy involved, he also felt discounting future health effects and costs were appropriate. In his abatement research, Dr. Dewees considered "only the willingness-to-pay of the worker to simplify the analysis." When designing the model, he realized that the death of a worker impacts on others and the total willingness-to-pay was underestimated. [Ref 16: p. 382]

> "Since a person's willingness to pay per unit of risk reduction decreases with his wealth, he will be willing to spend relatively more for initial than for subsequent reductions in risk since his assets become depleted with each successive purchase of a decrease in risk."
> [Ref 17: p. 95]

The willingness to pay for a statistical life is much lower than the willingness to pay for an individual life. Last year a small child fell into an abandoned well and extreme amounts of labor, effort and resources were expended to release her. The same amount of resources have not been spent to cap all remaining abandoned wells since that incident, suggesting we are willing to pay much less for a statistical life than for an individual life.

Dr. Dewees assumed that average worker exposure was 1 f/cc, one half the control limit at the time. As expected, he found the cost of reducing the mortality risks from asbestos exposure increased as the standard became more stringent. Table 1 lists the imposed costs of making the standard more stringent. In textile plants, it was felt existing technology could reduce the standard from 0.5 f/cc to 0.2 f/cc without incurring additional costs. All costs use a 4% discount rate. [Ref 16: p. 390]

> "The Royal Commission on Asbestos recommended a 1.0 f/cc control limit for general chrysotile manufacturing including friction products, and banned the use of crocidolite and the use of asbestos in textile plants." [Ref 16: p. 391]

In the United States, however, the EPA promogulated rules for

TABLE I

Cost of Reducing Mortality Risks From Asbestos Exposure (1983 Canadian Dollars)

Control Limit (f/cc)	Asbestos Cement (Crocidolite)	Friction Products (Chrysotile)	Textiles (Chrysotile)
Discounted Marginal Cost per life saved ($000,000/life)			
1.0	0.534	368	3.63
0.5	0.330	1,375	23.10
0.2	17.900	10,689	0.00
Ban	12.800*	3,840*	60.00
Discounted Marginal Cost per life-year saved ($000,000/life-year)			
1.0	0.046	34.8	0.34
0.5	0.029	130.0	2.19
0.2	1.570	1,012.0	0.00
Ban	1.130*	364.0*	5.72

* Compared to 0.5 f/cc

schools to have the asbestos identified and caused panic among teachers, parents and maintenance workers.

E. Value of a Life

Returning to the model of Figure 4, the results of the Royal Commission on Asbestos model can't tell us where we are on the graph. They do recommend we move to the left by lowering the level of exposure from 2 f/cc to 1 f/cc (estimated to cost between $4-$4.1 billion in 1980 dollars). [Ref 17: pp. 12-13] Since 1984, the 2 f/cc standard has been lowered to 0.2 f/cc, indicating movement to lower levels of exposure. With the recent EPA phased ban of all asbestos, we may be moving farther yet to the left.

In 1982, Viscusi found the cost per life saved ranged from $6 to $100 million for occupational health programs. Many studies have been conducted from 1975 - 1989 comparing the marginal willingness to pay for reductions in risk. The empirical evidence suggests a range for the "value-per-statistical-life" to be between $1.6 million and $8.5 million. [Ref 18: p. 90] Some argue that the government could spend no more than $100,000 to save a life from an automobile fatality. If our tax dollars were used to reduce traffic accidents, we might be able to save thousands of lives for the price we are paying to save one life through the more stringent abatement standards.

F. Asbestos Removal

When an inspection is conducted in a building and asbestos is identified, should asbestos be removed immediately or left in place? If it is removed, has the threat to the occupant's health increased or decreased? What is more cost effective? As Dewees states:

> "Although asbestos has been a major cause of premature mortality among the workers who installed the insulation that concerns us today, current levels of exposure in buildings are sufficiently low that there is no risk that occupants will develop asbestosis." [Ref 19: p. 286]

In this study, Dewees looked at the occupant's risk of developing mesothelioma as a function of exposure. He stated most models are for a 10 year latency period but coefficients developed in the model are taken from workers exposed to a much higher concentration level of asbestos. Past study results vary significantly. The unknown concentration levels and the results' variance both cause uncertainty. [Ref 19: p. 286] According to the EPA,

> "50% of all concentrations of airborne asbestos fibers in school lie between 0.00003 and 0.003 f/cc." [Ref 19: p.287]

In another RCA study, an exposure rate of 0.001 f/cc was used to represent an above-average concentration of exposure for building occupants. Based on this exposure rate, Dewees believes the risk is 1/50 of the risk of a highway fatality, 1/60 of the risk of being exposed to second hand smoke for 7 hours per week and 1/3 the risk of cancer from natural radiation of the bricks in the building itself.

[Ref 19: p. 287]

He argues the removal costs (in 1987) average between $4 - $10 per square foot of surface material removed and $5 per square foot of floor space for relocating occupants. If removal is delayed until demolition, the costs to relocate occupants is saved along with added precautions to protect existing furnishings. If removal is delayed, precautions must be taken to protect existing asbestos from damage, and safeguard building workers. New technology may be developed in the future that could reduce the cost of removal. If the risks for leaving the asbestos in place are minimal "we should resist squandering our resources on crash programs of asbestos removal." [Ref 19: p. 287-288]

The cost of asbestos abatement is increased from 15-40% of the contract for a public contract because of the added paperwork. This provides "documentation" to the administering activities according to a survey conducted in the Seattle/Tacoma area. Most contractors felt the extra paperwork required was unnecessary, useless and needlessly raised the abatement costs. [Ref 20: Appendix D]

G. Effects of Smoking

The latency period for diagnosis of asbestos related diseases normally occurs from 15 - 40 years after the onset of exposure. Some symptoms of asbestos may not appear for 30-40 years from the start of employment. [Ref 9: p. 114] In 1959, a group of 1,078,894 people in 25 states were enrolled in a long term study by the American Cancer Society. All participants were over 30 years of age and were studied for effects caused by asbestos exposure and smoking. The sample consisted of the four groups listed in Table 2.

Asbestos workers who smoke significantly increase their risk of death. Table 2 compares age-standardized lung cancer death rates (per 100,000 man-years) for cigarette smoking and/or occupational exposure to asbestos dust compared with no smoking and no occupational exposure to asbestos dust. [Ref 21: p. 487]

The results indicated that those who smoked were 10 times more likely to die from lung cancer when compared to the control group. Individuals exposed to asbestos were 5 times more likely to die from lung cancer when compared to the control group. The highest risk category is the individual who smoked and was exposed to asbestos.

TABLE II

Lung Cancer Death Rates for Cigarette Smoking and Asbestos Exposure

Group	Exposed to Asbestos	Smoker	Mortality Ratio *
Control	No	No	1.00
Asbestos Worker	Yes	No	5.17
Control	No	Yes	10.85
Asbestos Worker	Yes	Yes	53.24

* Rate per 100,000 man-years standardized for age on the distribution of the man-years of all the asbestos workers. [Ref 21: p. 487]

Another study was conducted by J. C. McDonald in 1980. The International Agency for Research on Cancer published his report titled "Asbestos-Related Diseases: An Epidemiological Review." His research found that smokers exposed to slight amounts of asbestos were 11.8 times more likely to develop lung cancer when compared to non-smokers exposed to the same amounts of asbestos. [Ref 15: p. 192]

H. Conclusion

When evaluating more stringent standards, past models use death rates of workers exposed to very high or unknown concentrations of airborne asbestos. Because test results vary significantly, there is a great deal of uncertainty in their merit. With a latency period of 15 - 40 years, the effects of our actions may not be known for some time. Although more study is certainly needed, the caliber of the additional study needs resolution. Economics does not appear to have played as big a role in policy as did panic and politics. The standard appears to have been lowered based on available technology, feasible work practices, engineering controls and statistical data on the number of lives that might be saved. When comparing other occupational health programs to requiring more stringent asbestos standards, reducing the permissible exposure limit to 0.2 f/cc appears extremely expensive. The restrictive actions taken today could be more severe than the threat warrants.

V. SUMMARY AND CONCLUSIONS

A. Summary

Asbestos is a naturally occurring mineral fiber that has been used for thousands of years in thousands of applications. Its low cost, coupled with its unique physical properties make it extremely difficult to replace. Asbestos will be around for many years after the EPA's ban takes effect.

There are no clear guidelines when dealing with asbestos. Each month numerous studies are published. Many have conflicting results about the health effects caused by asbestos. Most experts tend to agree on the following points however:

> 1. "Prolonged occupational exposure to heavy concentrations of asbestos dust, in the absence of personal protective devices, can measurably increase the chances of a person contracting a type of pneumoconiosis called asbestosis.. "Exposure to asbestos may increase the chances of contracting the very rare type of cancer called mesothelioma.. "Asbestos workers exposed to heavy concentrations of dust without respiratory protection, and who are also heavy smokers, have increased chances for contracting lung cancer." [Ref 2: p. 9]

The Occupational Safety and Health Administration standards attempt to protect the worker, while the general public is protected through standards set by the EPA. Action by the government over the past 20 years has provided a <u>much</u> safer work environment.

B. Problems Noted

1. Misinformation and Panic

There is a great deal of ignorance, fear and panic when anyone mentions the word asbestos. Conflicting medical evidence, numerous lawsuits, a court system overloaded with litigation, and sensationalism by the media help spread the fear.

In March 1985, 25,000 lawsuits against 30 asbestos manufacturer's were heard in San Francisco's Nourse Auditorium [Ref 8: p. 74]. In April 1991, 9032 lawsuits are being consolidated in Baltimore's Circuit Court because of the extreme backlog. The large number of cases are a dilemma the courts face, and consolidation seems to provide the only relief in clear their dockets. An estimated 90,000 lawsuits are still pending in the courts. Because of these delays, some plaintiffs die before getting to court since the average life span after diagnosis is about two years.

In a 1986 interview, Tom Stephens, the President and Chief Executive at Manville Corporation thought the government took too long in setting the standards. He felt the knowledge of harmful effects was reported in 1964. At the time of the interview, Manville was paying approximately $75 million per year to the trust funds they had set up for litigation compensation. He went on to state "it doesn't seem quite right that a hefty portion of the compensation is going to end up in the pockets of lawyers." [Ref 22: p. 65] The only ones not hurt in this quagmire appear to be the lawyers. There is a movement forming that attempts to limit the lawyers portion to a maximum of 30% of the settlement.

2. **Standards Too Stringent?**

a. Technology Features and Shortcomings

The permissible exposure level standards were limited by sampling and testing technology available at the time. OSHA based the 0.2 f/cc on technical feasibility, given work practices, and engineering controls. OSHA argued that at a standard of 10 f/cc there would be 165 excess deaths per 1,000 subjects. At 1 f/cc the number was expected to fall to 64 deaths per 1,000 subjects. [Ref 1: p. 66] NIOSH agreed the standard was lowered based on available technology of analytical techniques. [Ref 14: p. 93] Using the mandatory OSHA Reference Method, positive identification of asbestos fibers cannot be distinguished from other fibers in the sample.

b. A Possible Threshold Exists

As discussed in the previous chapter, a threshold level may exist that does not pose a danger to humans. The possible alternatives range from 1.5 - 5 f/cc, but all studies recorded thus far have unknown or sketchy concentration exposure levels. The results of the more stringent standards may not be known for 15 - 40 years.

3. Risks from Smoking

There is a general consensus that smoking combined with asbestos inhalation significantly increases the risk of lung cancer. Several studies have linked the increased risk created when smokers are exposed to asbestos. [Ref 15: pp. 191-192] One of the ways the Johns-Manville Corporation reduced the risk of cancer, was not allowing smokers to be employed in their asbestos plants. [Ref 17: p. 133]

4. Is Society Paying Too Much?

The costs for abatement appear excessively high. Based on the economic analysis presented in the previous chapter, our society could allocate funds more effectively on other programs that save many more life-years for the same amount of funds.

a. Death Rates Compared to Lung Cancer

There is an information gap in the actual death rate caused by the effects of asbestos. An article published in 1986 implied the EPA estimated asbestos related deaths at 8,000 - 10,000 per year because of products in use today. [Ref 23: p.28]

Data from the Vital Statistics of the United States, Volume II, Part A, list only 882 deaths from asbestos from 1968 through 1982. During that same period of time, there were 1,256,111 deaths listed from lung cancer. [Ref 3: p. 134]

In another study of a 15 year period (1960-1975), there were 668 cases of mesothelioma identified in all of Canada and the United States. In the United States alone, in one year, there were 50,481 deaths caused by lung cancer suggesting a very low rate of mesothelioma. [Ref 15: p. 197]

It's ironic that death from asbestos comprises only a small fraction of the total lung cancer deaths recorded each year, but our country subsidizes farmers to grow tobacco even though smoking could be the largest single cause of lung cancer.

C. Conclusions

Direct studies need to be conducted with different cohorts that link accurate asbestos exposure levels to death rates. The first more stringent standard was adopted in 1971. Results of this change should begin to surface during the latency period from 1986 to 2011.

Because data was not available that proved a "safe" threshold level exists, the action of the government may have been too severe. While we do have a much safer work environment than existed 30 years ago, I feel our nation has paid too high a price for this haste.

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